



US009143647B2

(12) **United States Patent**
Shimizu

(10) **Patent No.:** **US 9,143,647 B2**
(45) **Date of Patent:** **Sep. 22, 2015**

(54) **IMAGE READING APPARATUS AND METHOD, IMAGE FORMING APPARATUS, AND COMPUTER-READABLE MEDIUM**

USPC 358/449
See application file for complete search history.

(71) Applicant: **FUJI XEROX Co., Ltd.**, Minato-ku, Tokyo (JP)

(56) **References Cited**

U.S. PATENT DOCUMENTS

(72) Inventor: **Kosuke Shimizu**, Kanagawa (JP)

2003/0010903 A1 * 1/2003 Hsu 250/222.1
2006/0193013 A1 * 8/2006 Hoshi 358/474
2006/0208157 A1 * 9/2006 Michiie 250/208.1
2007/0201076 A1 * 8/2007 Ishida 358/1.14
2007/0201918 A1 * 8/2007 Shoda et al. 399/376

(73) Assignee: **FUJI XEROX CO., LTD.**, Tokyo (JP)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 22 days.

FOREIGN PATENT DOCUMENTS

(21) Appl. No.: **13/750,675**

JP 2004-109639 A 4/2004

(22) Filed: **Jan. 25, 2013**

* cited by examiner

(65) **Prior Publication Data**

US 2014/0022605 A1 Jan. 23, 2014

Primary Examiner — Huo Long Chen

Assistant Examiner — Moustapha Diaby

(74) *Attorney, Agent, or Firm* — Sughrue Mion, PLLC

(30) **Foreign Application Priority Data**

Jul. 19, 2012 (JP) 2012-160916

(57) **ABSTRACT**

(51) **Int. Cl.**
H04N 1/04 (2006.01)
H04N 1/40 (2006.01)
H04N 1/00 (2006.01)

An image reading apparatus includes a document cover, a cover state detector that detects whether the document cover is open or closed, an image reading unit that reads an image by conducting an optical scan that moves a scanning body with a mounted light source, detecting reflected light from the target object with a photoelectric transducer, and outputting a signal expressing the detected pixel densities, a white reference plate used as a reference for correcting an image, a power manager that switches between a power-saving state and a standby state, and a controller that controls the respective units such that in the case of restoring the standby state due to detecting the opening or closing of the document cover, an image of a document is read to detect the document size, and an image of the white reference plate is read after the detection to acquire correction values.

(52) **U.S. Cl.**
CPC **H04N 1/00896** (2013.01); **H04N 1/0005** (2013.01); **H04N 1/00013** (2013.01); **H04N 1/00037** (2013.01); **H04N 1/00082** (2013.01); **H04N 1/00708** (2013.01); **H04N 1/00551** (2013.01); **H04N 2201/044** (2013.01)

(58) **Field of Classification Search**
CPC H04N 1/00013; H04N 1/00037; H04N 1/0005; H04N 1/00082; H04N 1/00551; H04N 1/00708; H04N 1/00896; H04N 2201/044

13 Claims, 15 Drawing Sheets

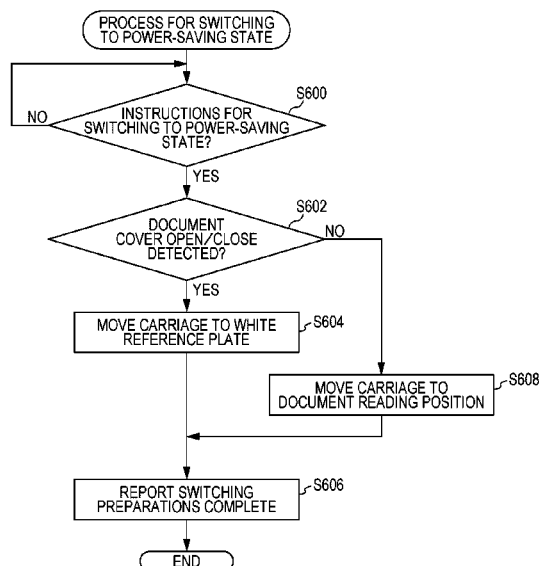


FIG. 1

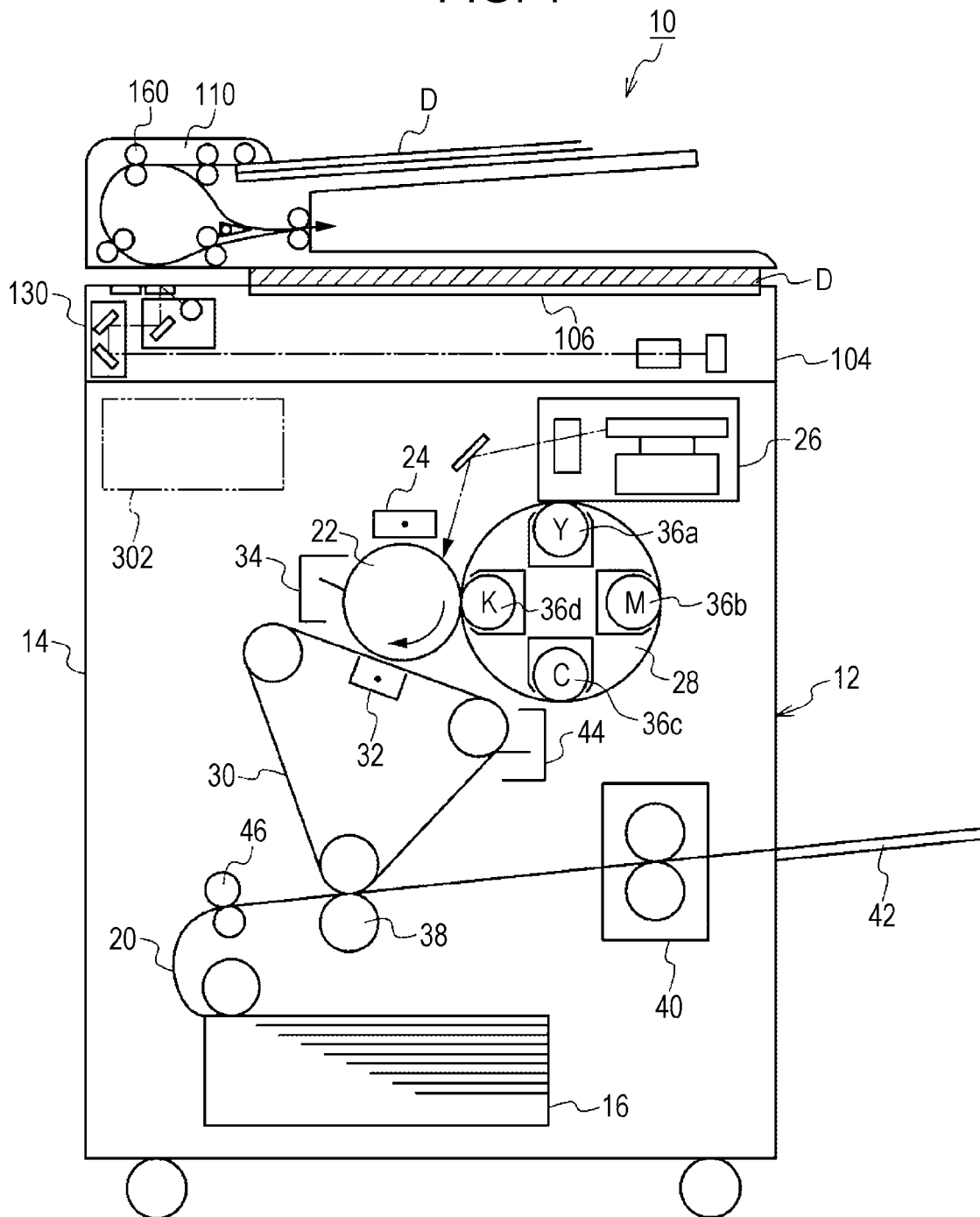


FIG. 2

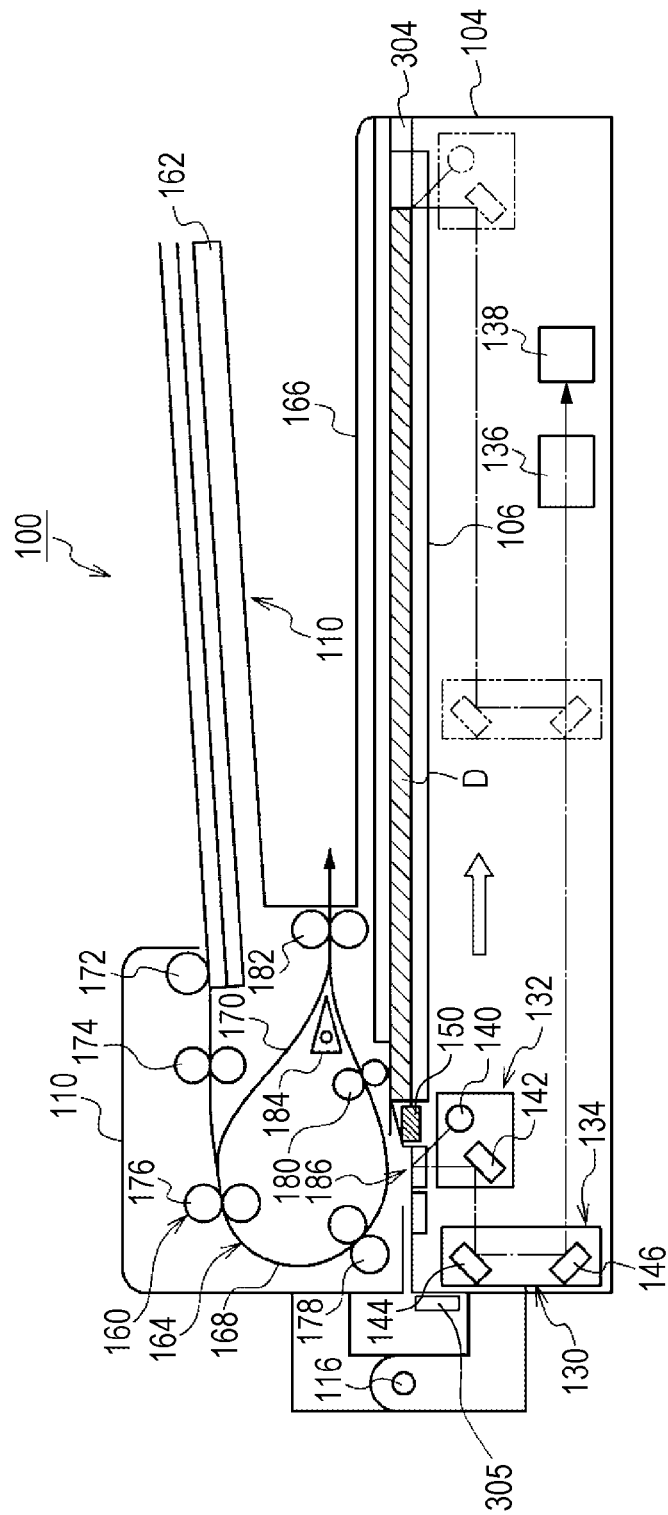


FIG. 3

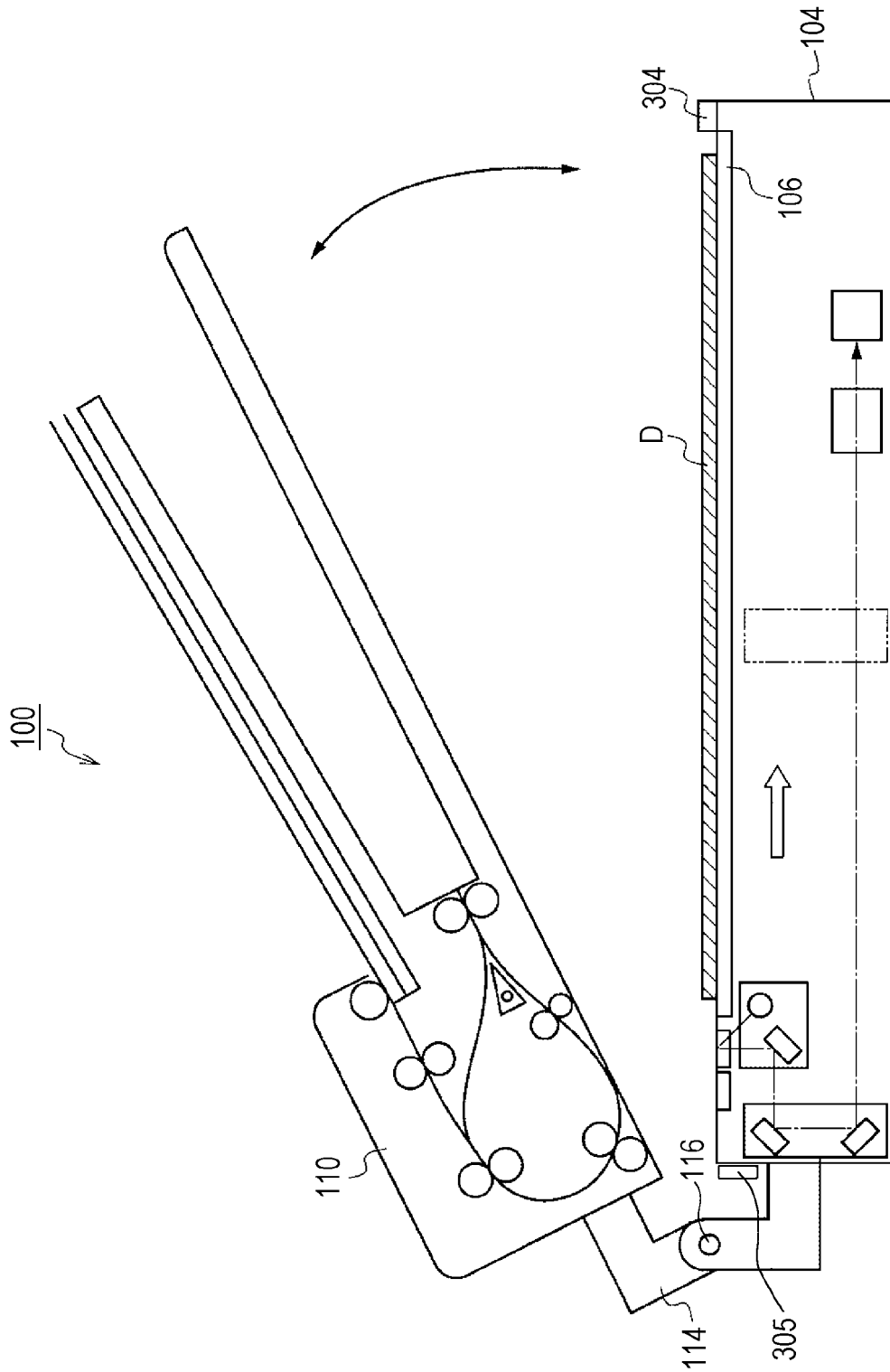


FIG. 4

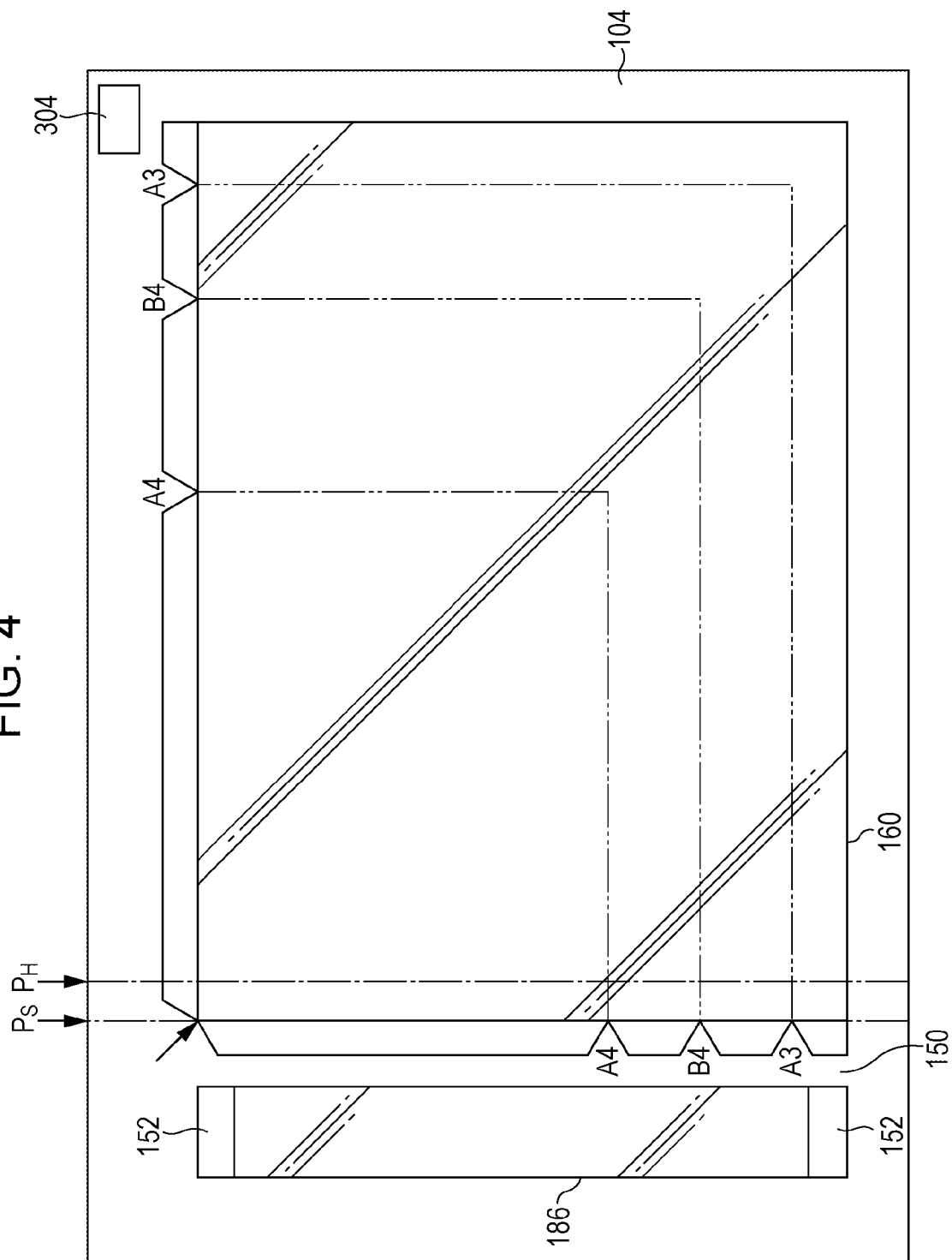


FIG. 5

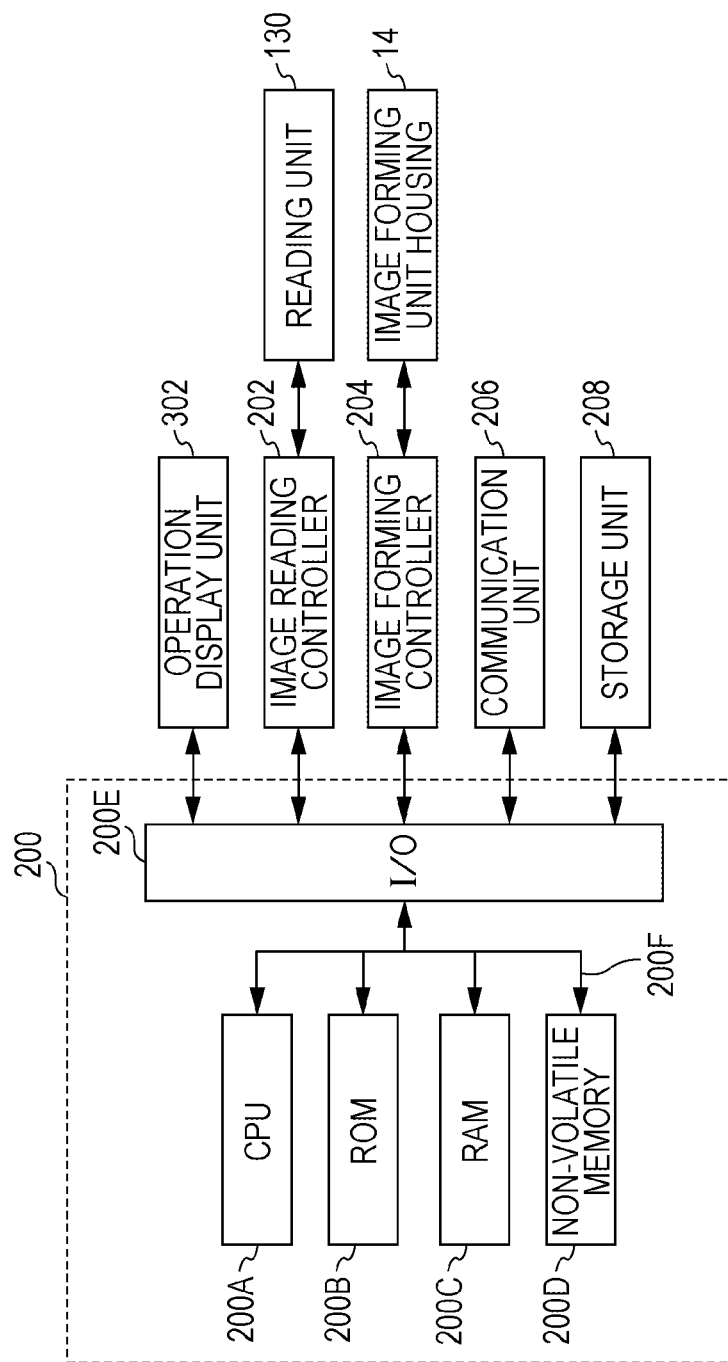


FIG. 6

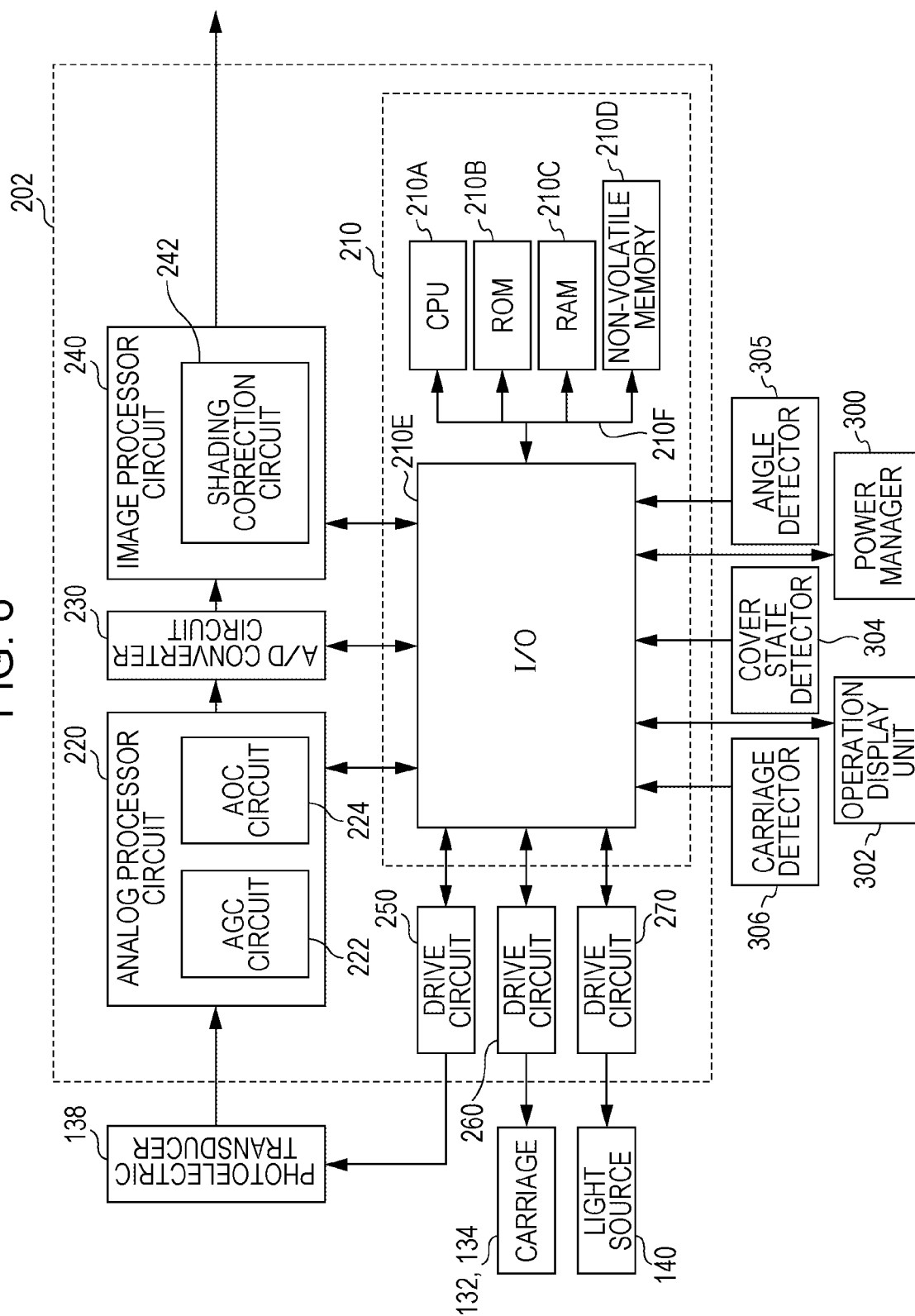


FIG. 7

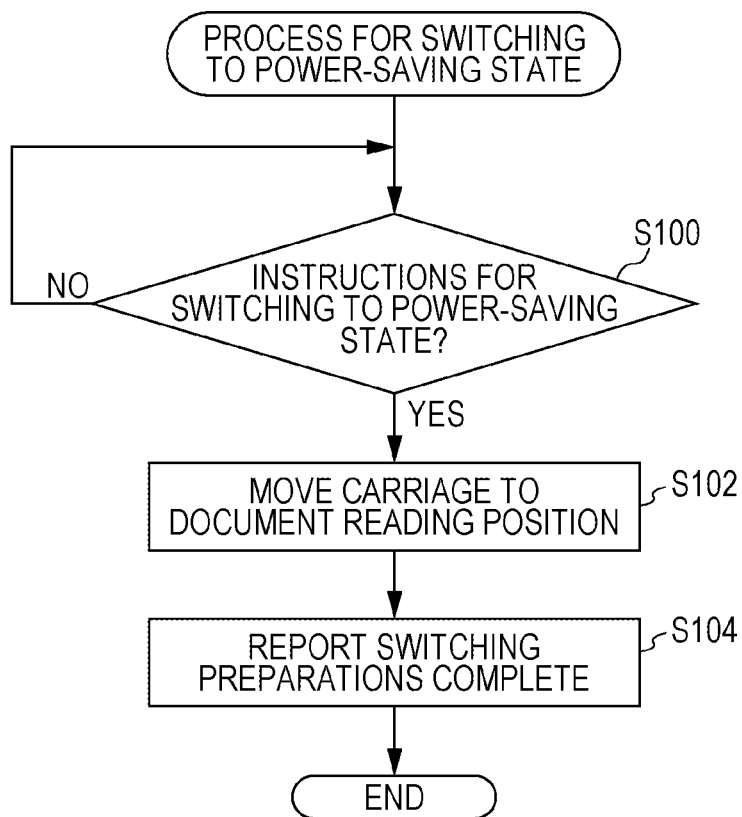


FIG. 8

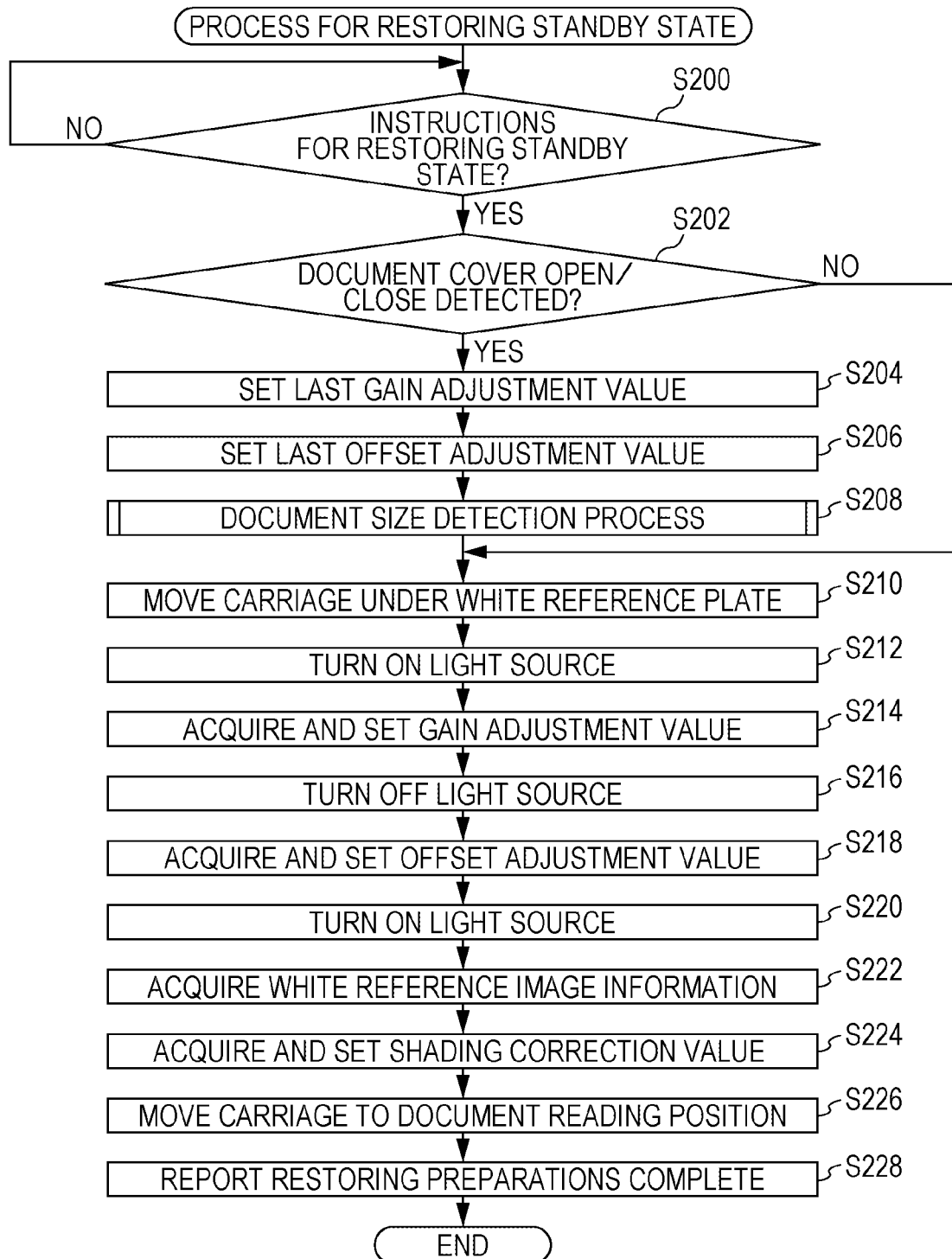


FIG. 9

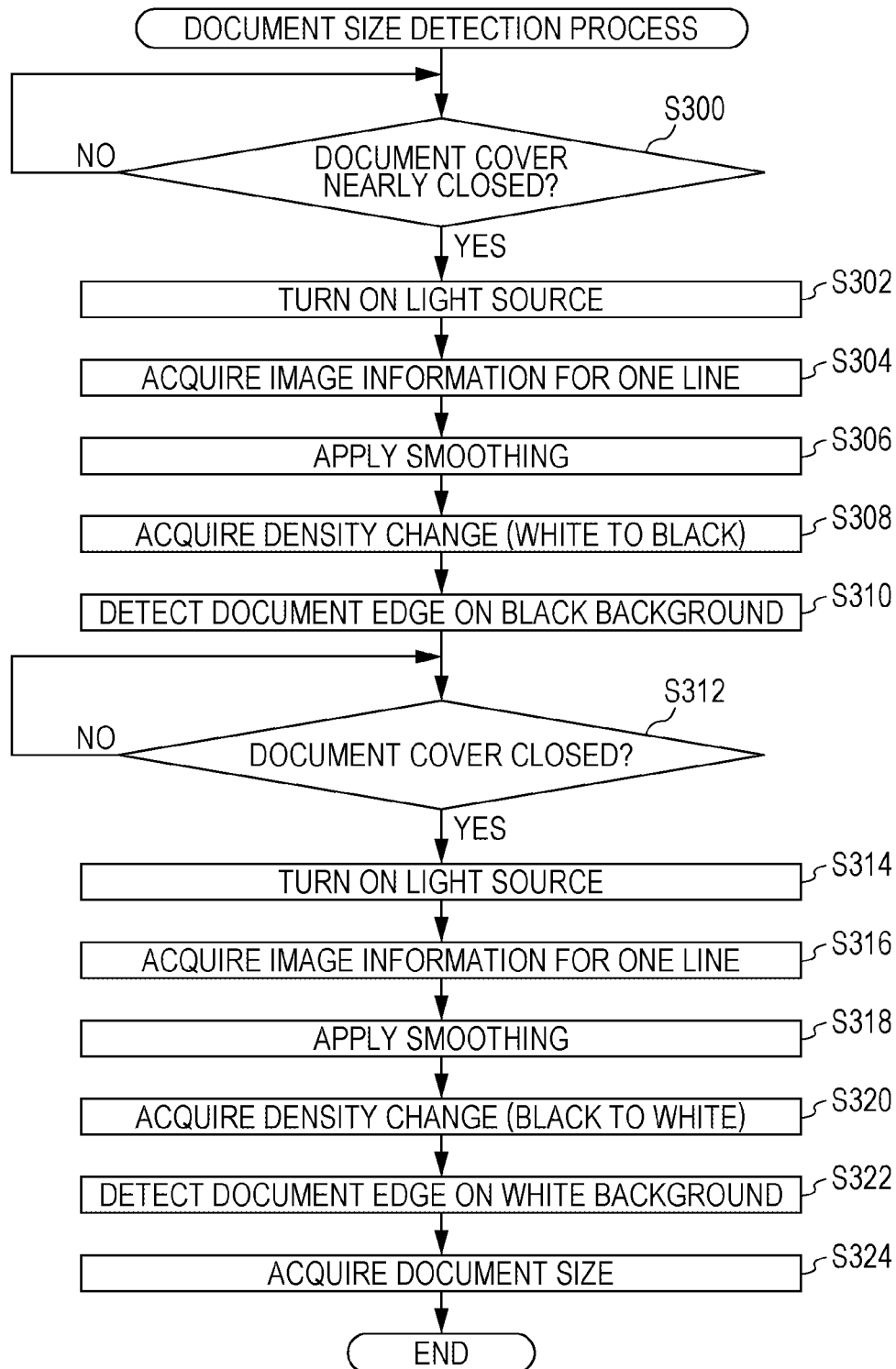


FIG. 10

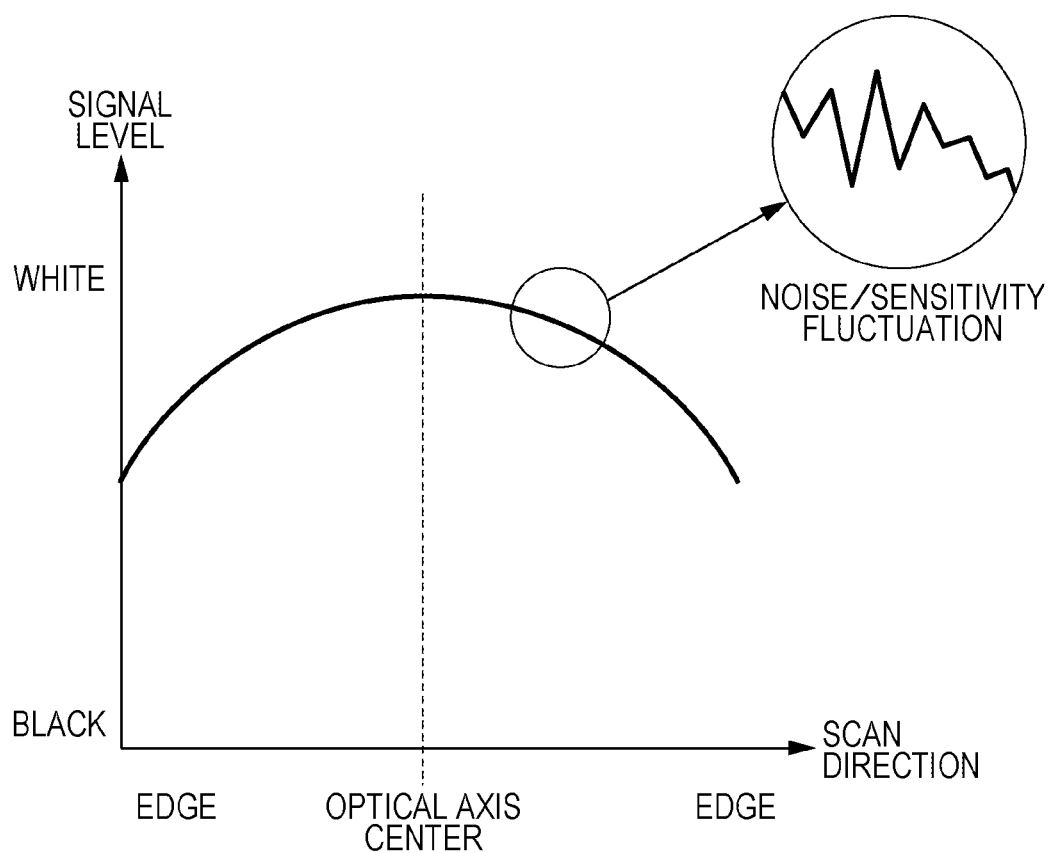


FIG. 11A

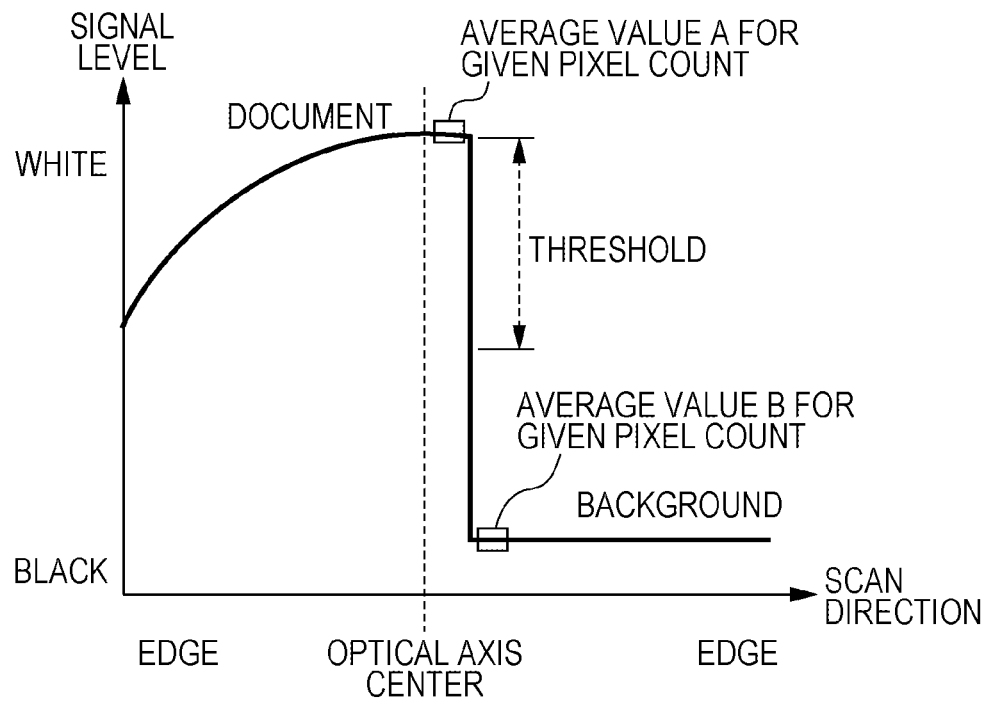


FIG. 11B

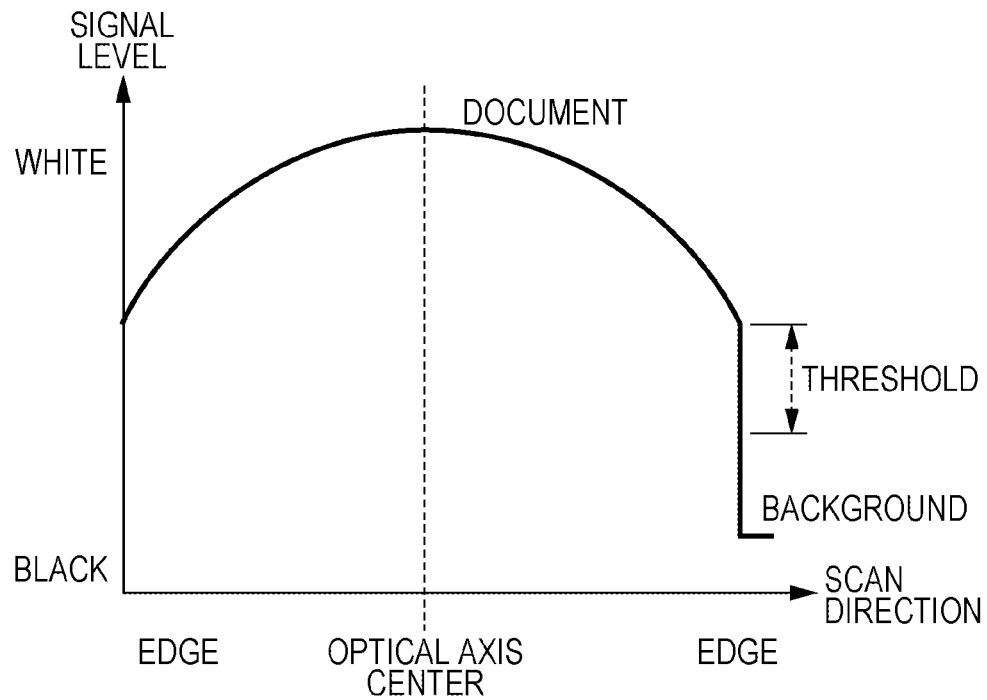


FIG. 12

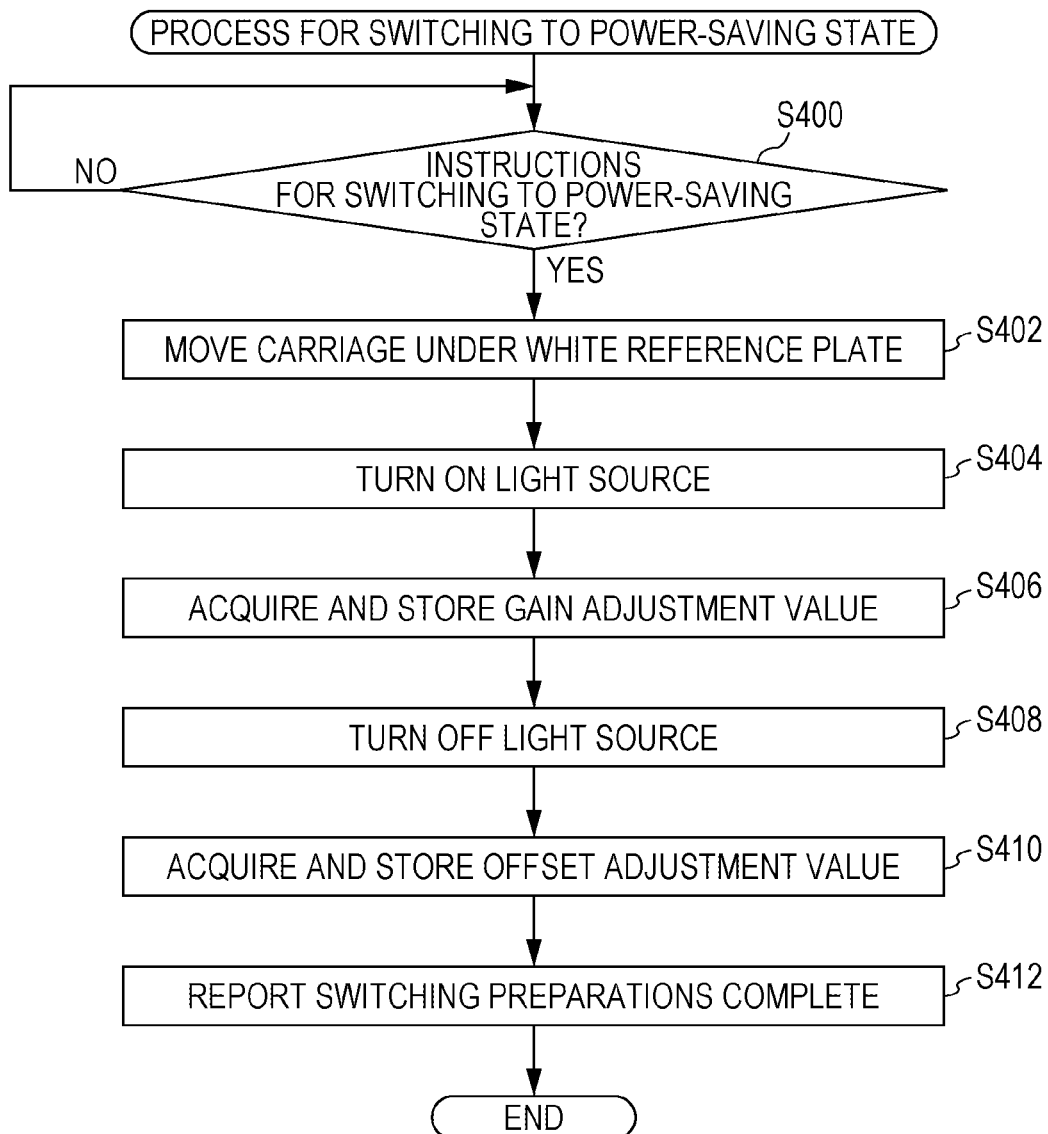


FIG. 13

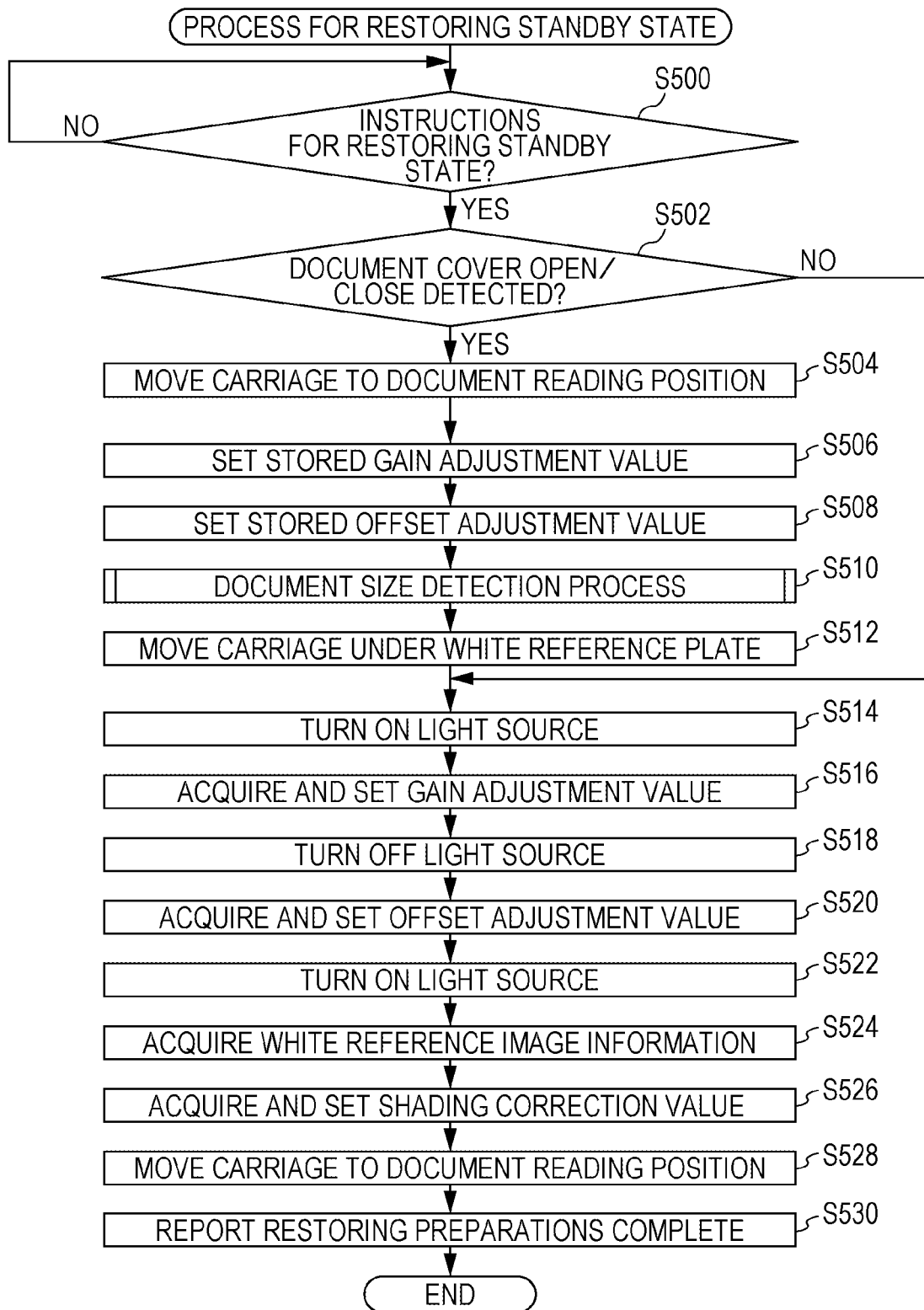


FIG. 14

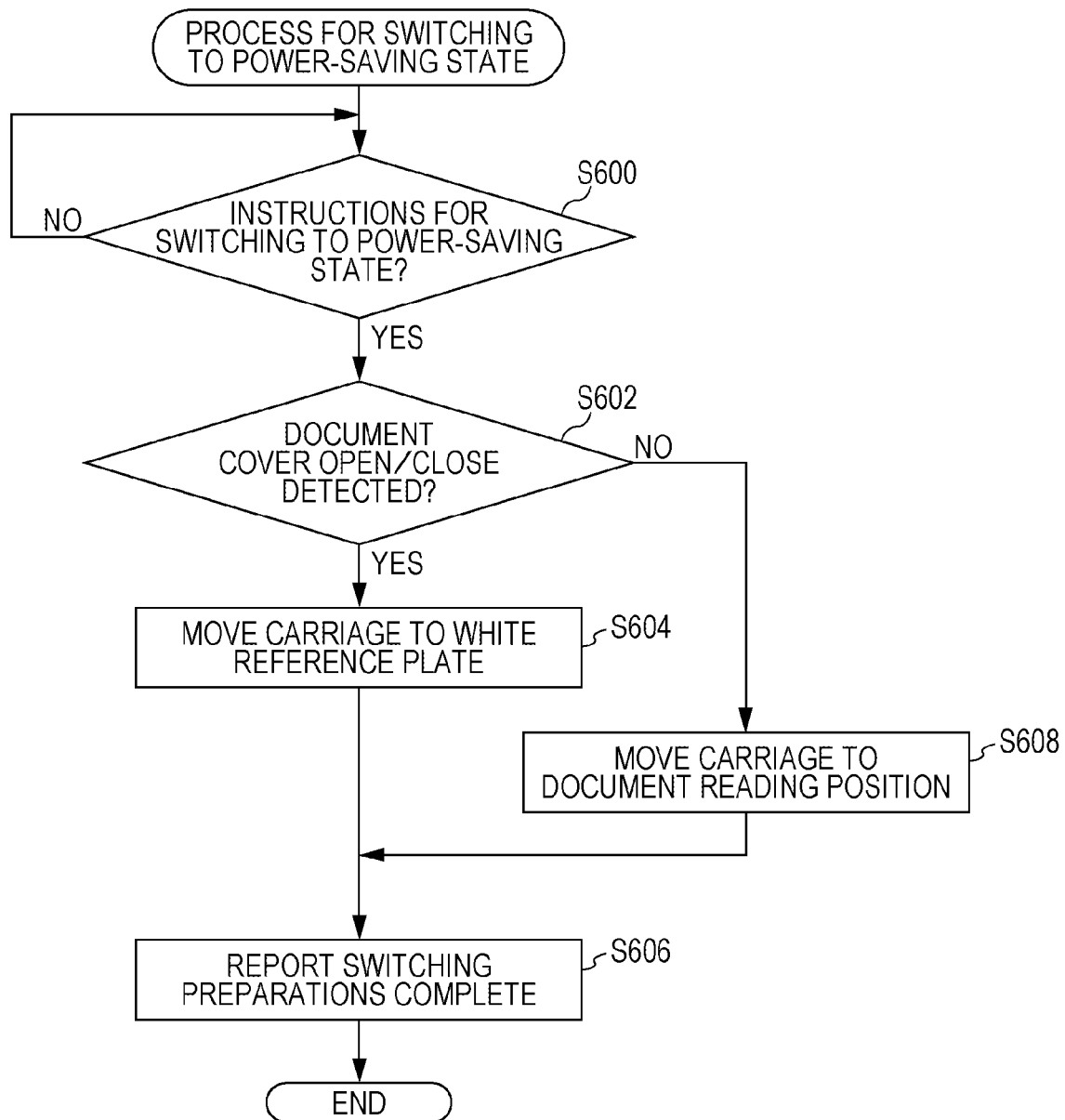
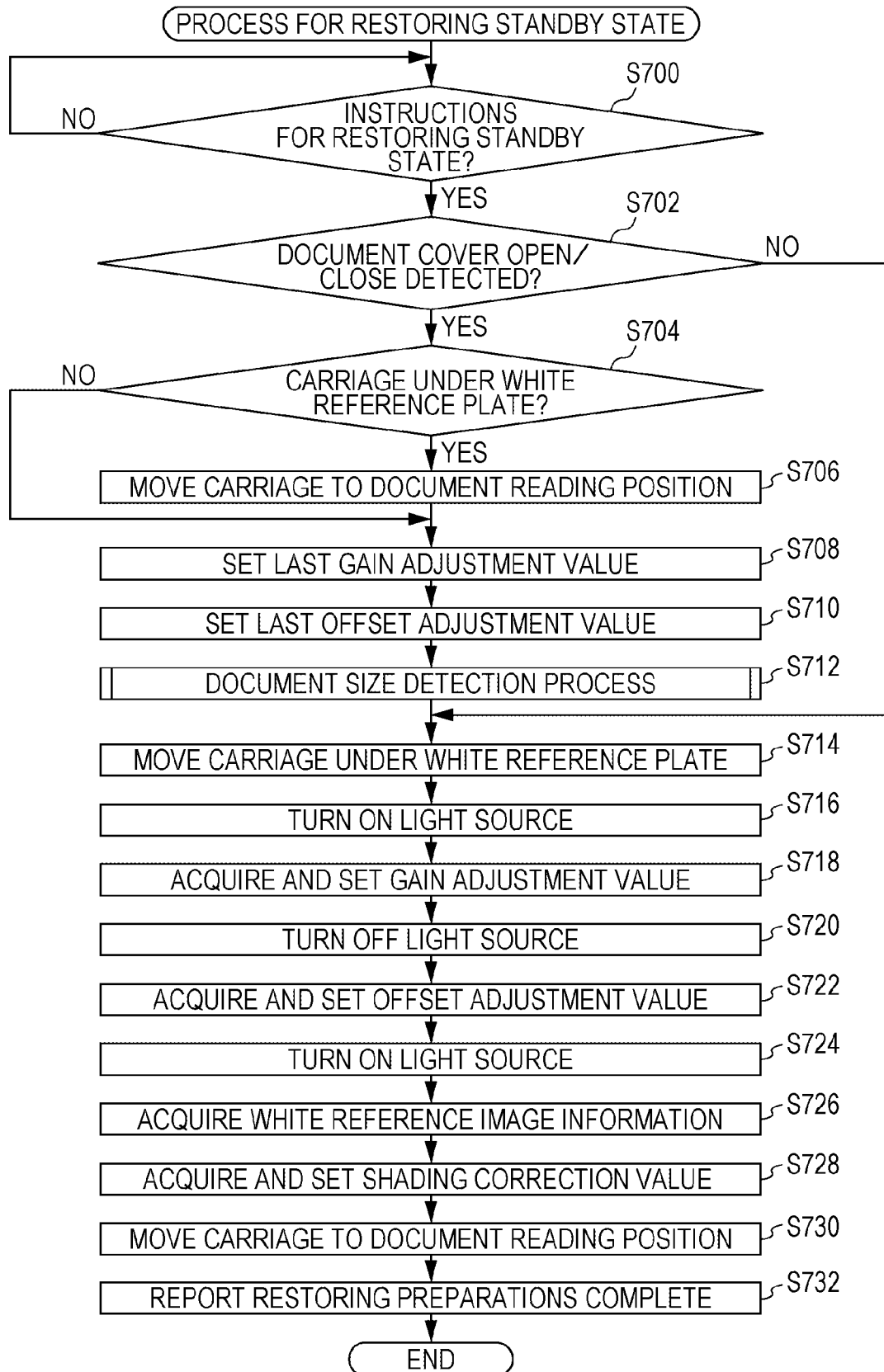


FIG. 15



1

IMAGE READING APPARATUS AND METHOD, IMAGE FORMING APPARATUS, AND COMPUTER-READABLE MEDIUM

CROSS-REFERENCE TO RELATED APPLICATIONS

This application is based on and claims priority under 35 USC 119 from Japanese Patent Application No. 2012-160916 filed Jul. 19, 2012.

BACKGROUND

Technical Field

The present invention relates to an image reading apparatus and method, an image forming apparatus, and a computer-readable medium.

SUMMARY

According to an aspect of the invention, there is provided an image reading apparatus that includes a document cover, a cover state detector that detects whether the document cover is open or closed, an image reading unit that reads an image of a target object by conducting an optical scan that moves a scanning body with a mounted light source, detecting reflected light from the target object with a photoelectric transducer, and outputting a signal expressing the detected pixel densities, a white reference plate used as a reference for correcting an image, a power manager that switches between a power-saving state and a standby state, and a controller that controls the respective units such that in the case of restoring the standby state due to detecting the opening or closing of the document cover, an image of a document is read to detect the document size, and an image of the white reference plate is read after the detection to acquire correction values.

BRIEF DESCRIPTION OF THE DRAWINGS

Exemplary embodiments of the present invention will be described in detail based on the following figures, wherein:

FIG. 1 is a schematic diagram illustrating an exemplary configuration of an image forming apparatus according to an exemplary embodiment of the present invention;

FIG. 2 is a schematic diagram illustrating an exemplary configuration of an image reading apparatus according to an exemplary embodiment of the present invention;

FIG. 3 is a schematic diagram illustrating a state in which the document cover of the image reading apparatus illustrated in FIG. 2 is open;

FIG. 4 is a plan view illustrating the platen of the image reading apparatus illustrated in FIG. 2;

FIG. 5 is a block diagram illustrating an exemplary configuration of the control subsystem of an image forming apparatus according to an exemplary embodiment of the present invention;

FIG. 6 is a block diagram illustrating an exemplary configuration of the image reading controller illustrated in FIG. 5;

FIG. 7 is a flowchart illustrating the sequence of a process for switching to a power-saving state, which is executed according to a first exemplary embodiment of the present invention;

FIG. 8 is a flowchart illustrating the sequence of a process for restoring the standby state, which is executed according to a first exemplary embodiment of the present invention;

2

FIG. 9 is a flowchart illustrating the sequence of a document size detection process, which is executed according to a first exemplary embodiment of the present invention;

FIG. 10 is a graph illustrating white reference image information;

FIG. 11A is a graph illustrating a threshold set with respect to density change at the optical axis center, while FIG. 11B is a graph illustrating a threshold set with respect to density change at the edge;

FIG. 12 is a flowchart illustrating the sequence of a process for switching to a power-saving state, which is executed according to a second exemplary embodiment of the present invention;

FIG. 13 is a flowchart illustrating the sequence of a process for restoring the standby state, which is executed according to a second exemplary embodiment of the present invention;

FIG. 14 is a flowchart illustrating the sequence of a process for switching to a power-saving state, which is executed according to a third exemplary embodiment of the present invention; and

FIG. 15 is a flowchart illustrating the sequence of a process for restoring the standby state, which is executed according to a third exemplary embodiment of the present invention.

DETAILED DESCRIPTION

Hereinafter, exemplary embodiments of the invention will be described in detail and with reference to the drawings.

First Exemplary Embodiment

(Image Forming Apparatus)

First, a configuration of an image forming apparatus will be described.

FIG. 1 is a schematic diagram illustrating an exemplary configuration of an image forming apparatus according to an exemplary embodiment of the present invention. As illustrated in FIG. 1, the image forming apparatus 10 includes an image reading apparatus 100 and an image forming unit 12 that forms an image on the basis of image information read by the image reading apparatus 100. The image forming unit 12 includes a sheet storage container 16 where sheets are stored in a stacked state, and forms an image on a sheet supplied to a sheet transport path 20 from the sheet storage container 16. In this exemplary embodiment, the image forming unit 12 forms an image with an electrophotographic system.

The image forming unit 12 includes an image forming unit housing 14. Disposed inside the image forming unit housing 14 are an image retainer 22 such as a photoreceptor drum, for example, a charger 24 that charges the image retainer 22, an exposing device 26 that forms a latent image on the image retainer 22 charged by the charger 24, a developing device 28 that renders the latent image on the image retainer 22 formed by the exposing device 26 visible with toner, an intermediate transfer belt 30 used as an intermediate transfer body, a first transfer device 32 that transfers the toner image formed on the image retainer 22 to the intermediate transfer belt 30, and a photoreceptor cleaner 34 that cleans up toner remaining on the image retainer 22.

Also disposed inside the image forming unit housing 14 are a second transfer device 38 that transfers the toner image that was transferred onto the intermediate transfer belt 30 to a sheet, a fusing device 40 that fuses the toner image transferred to a sheet, and an intermediate transfer belt cleaner 44 that cleans the intermediate transfer belt 30. Disposed on the front of the image forming unit housing 14 is an operation display unit 302 used as a user interface. Disposed on the side of the

3

image forming unit housing **14** is a delivery unit **42** where a sheet with an image formed thereon is delivered.

The exposing device **26** may be a laser scanning exposing device, for example, which converts and outputs image information from a document read with a photoelectric transducer **138** discussed later included in the image reading apparatus **100** (see FIG. 2) as a laser on/off signal. The developing device **28** may be a rotary developing device, for example, which includes developers **36a**, **36b**, **36c**, and **36d** for the four colors yellow (Y), magenta (M), cyan (C), and black (K) disposed around a rotary body. The rotary body of the developing device **28** rotates such that the developers for the respective colors successively face the image retainer **22**.

The first transfer device **32** may be realized with a corotron, for example. A 4-color toner image is transferred to the intermediate transfer belt **30** by the first transfer device **32**. The toner image transferred to the intermediate transfer belt **30** is transferred to a sheet by the second transfer device **38**. The sheet bearing the transferred toner image is supplied to the fusing device **40**. The toner image is fused to the sheet by the fusing device **40**. The sheet bearing the fused toner image is delivered to the delivery unit **42**. Toner remaining on the intermediate transfer belt **30** is scraped off by the intermediate transfer belt cleaner **44**.

The operation display unit **302** may include various buttons such as a Start button and a keypad, and a touch panel for displaying various screens such as settings screens. With the above configuration, the operation display unit **302** receives user operations while also presenting various information to the user. For example, when forming an image, formation of a monochrome image or a multi-color image may be selected, and settings such as the image magnification and quality may be set. Also, when reading an image, black and white reading or color reading may be selected, and settings such as the document read area, the document scanning speed (factor), the document transport method, and the document size may be set.

Disposed along the sheet transport path **20** is a registration roller **46**. The registration roller **46** is controlled so as to temporarily stop a supplied sheet and supply the sheet to the second transfer device **38** in synchronicity with the timing at which a toner image is formed on the intermediate transfer belt **30**.

The image reading apparatus **100** includes a platen **104** on which a document D is placed, and a document cover **110** provided in an openable and closable manner with respect to the platen **104**. The platen **104** includes a transparent member **106** realized with a light-transmitting material such as glass, for example.

The platen **104** is formed as a housing. Disposed inside the platen **104** is a reading unit **130** that radiates light onto a document placed on the transparent member **106**, and reads in an image of a document on the basis of reflected light from the document. A document transport device **160** that automatically transports the document D is also installed inside the document cover **110**. The image reading apparatus **100** is equipped with functionality for reading in an image of a document D being transported by the document transport device **160**, as well as functionality for reading in an image of a document D placed on top of the transparent member **106**.

In addition, in this exemplary embodiment, the image forming apparatus **10** is equipped with power-saving functionality that reduces power consumption in the image forming apparatus. Specifically, the image forming apparatus **10** includes a power manager **300** (see FIG. 6) that manages the power supply states for respective units, including the reading unit **130**. As discussed later, the power manager **300** switches

4

between a "power-saving state" in which power is supplied to part of the apparatus, and a "standby state" in which power is supplied to the entire apparatus.

(Image Reading Apparatus)

Next, a configuration of an image reading apparatus will be described.

FIG. 2 is a schematic diagram illustrating an exemplary configuration of an image reading apparatus according to an exemplary embodiment of the present invention. FIG. 3 is a schematic diagram illustrating a state in which the document cover of the image reading apparatus illustrated in FIG. 2 is open. As illustrated in FIGS. 2 and 3, the image reading apparatus **100** includes a hinge **114** equipped with an axle **116**. The platen **104** and the document cover **110** are linked by the hinge **114**. The document cover **110** opens and closes with respect to the platen **104** by rotating about the axle **116**. In the state where the document cover **110** is closed, the transparent member **106** becomes covered, as illustrated in FIG. 2.

In addition, a cover state detector **304** that detects whether the document cover **110** is open or closed and an angle detector **305** that detects the angle at which the document cover **110** is open or closed are attached to the image reading apparatus **100**. With the cover state detector **304** and the angle detector **305**, at least three states are detected: a state in which the document cover member is wide open (open state), a state in which the document cover is nearly closed (nearly closed state), and a state in which the document cover is fully closed (closed state).

The document transport device **160** transports a document from a document receptacle **162** where a document is placed before reading, and includes a document transport path **164** and a delivery receptacle **166** where a document is delivered after an image is read. The document transport path **164** includes a simplex section **168** and a duplex section **170**. The simplex section **168** is U-shaped. A pickup roller **172**, a feed roller **174**, a registration pre-roller **176**, a registration roller **178**, a feed roller **180**, and a delivery roller **182** which constitute a transport device are disposed in order along the simplex section **168** starting from the upstream side in the document transport direction.

The pickup roller **172** descends when feeding a document, and picks up a document placed in the document receptacle **162**. The feed roller **174** loosens the document supplied from the pickup roller **172**, and supplies the uppermost document to the registration pre-roller **176**. The registration pre-roller **176** is configured to perform skew correction by temporarily stopping the document supplied from the feed roller **174** to form a loop. The registration roller **178** temporarily stops the document sent from the registration pre-roller **176** and adjusts the read timings. When delivering a document, the delivery roller **182** is rotated forward and the document is delivered into the delivery receptacle **166** via the feed roller **180** and the delivery roller **182**.

One end of the duplex section **170** is connected to the simplex section **168** between the feed roller **180** and the delivery roller **182**, while the other end is connected to the simplex section **168** upstream to the registration pre-roller **176**. A reversal gate **184** is provided at the one end of the duplex section **170**. When reversing a document, the delivery roller **182** is rotated backward at the stage where the trailing edge of the document reaches the delivery roller **182**, and the document is guided into the duplex section **170** by positioning the reversal gate **184** downward. The reversal gate **184** may also be configured to open due to the pressing force of a document, and close due its own weight. A driving unit that opens and closes the reversal gate **184** may also be provided.

Also, a transported document reading position **186**, being the position where a document is read when a document is previewed during transport, is provided along the simplex section **168**. The transported document reading position **186** is provided between the registration roller **178** and the feed roller **180**, and is configured to acquire an image of a document supplied by the document transport device **160**.

The reading unit **130** includes a full-rate carriage **132** as a first scanner, and a half-rate carriage **134**, lens **136**, and photoelectric transducer **138** as a second scanner. The full-rate carriage **132** includes a light source **140** and a first mirror **142**. As indicated by the arrow in FIG. 2, the full-rate carriage **132** is configured to perform a full stroke movement inside the platen **104** in the sub-scan direction, taking the document scan direction (sub-scan direction) as the movement direction.

The light source **140** is a lamp or other component extending in a first direction (the scan direction) intersecting the document transport direction. The light source **140** has a preset scan width in the scan direction. The half-rate carriage **134** includes a second mirror **144** and a third mirror **146**. The half-rate carriage **134** is configured to perform a half-stroke movement inside the platen **104** in the sub-scan direction.

As described above, the half-rate carriage **134** moves in the wake of the full-rate carriage **132**. Hereinafter, the full-rate carriage **132** and the half-rate carriage **134** will be designated the carriage **132** (**134**). The reading unit **130** is equipped with a carriage detector **306** that detects the carriage position. Note that the carriage position herein refers to the position of the full-rate carriage **132** equipped with the light source **140**.

The light source **140** radiates light onto a document placed on the transparent member **106** provided above the movement range of the full-rate carriage **132** and the half-rate carriage **134**, or onto a document that passes the transported document reading position **186**. The lens **136** receives reflected light reflected off the document via the first mirror **142**, the second mirror **144**, and the third mirror **146**, and forms an image on the photoelectric transducer **138**.

The photoelectric transducer **138** detects reflected light at the imaging forming position of the reflected light from the lens **136**, and outputs an analog electrical signal corresponding to the detected light intensity to a processor circuit discussed later. The photoelectric transducer **138** may be, for example, a 3-line color CCD that outputs an analog electrical signal corresponding to the detected light intensity for each of the RGB colors in units of pixels from a photodiode provided with an RGB color filter (primary color filter).

A first white reference plate **150** that reflects light radiated by the light source **140** is provided between the transported document reading position **186** and the transparent member **106**. In the first white reference plate **150**, the reflective surface that reflects light has a white color given as a reference, and is configured such that when the image forming apparatus **10** is powered on, for example, the light source **140** irradiates the first white reference plate **150** with light, and the reflected light therefrom (the default reference light intensity) is detected by the photoelectric transducer **138** via the first mirror **142**, the second mirror **144**, the third mirror **146**, and the lens **136**.

FIG. 4 is a plan view illustrating the platen of the image reading apparatus illustrated in FIG. 2. FIG. 4 illustrates the platen **104** in a state where the document cover **110** is open. As illustrated in FIG. 4, second white reference plates **152** that reflect light radiated by the light source **140** are respectively provided at the ends of the transported document reading position **186**. In the second white reference plates **152**, the reflective surface that reflects light has a white color given as

a reference, and is configured such that when the image reading apparatus **100** previews an image of a document, for example, the light source **140** irradiates the second white reference plates **152** with light, and the reflected light therefrom (the scanning reference light intensity) is detected by the photoelectric transducer **138** via the first mirror **142**, the second mirror **144**, the third mirror **146**, and the lens **136**.

The above cover state detector **304** is disposed on the upward-facing surface of the platen **104**. The cover state detector **304** is disposed outside the transparent member **106**. Also, guides are provided on the upward-facing surface of the platen **104**, which are used for document positioning in the case where the user places a document on top of the transparent member **106**. For example, guides used for document positioning according to the document type and size, such as A4, B4, and A3, may be indicated by a method such as printing, for example. Note that the double-dot chain lines in FIG. 4 indicate the document positions for the cases where an A4 document, a B5 document, and an A3 document are placed on the transparent member **106**, respectively.

In the case of reading an image of a document placed on top of the transparent member **106** in an image reading apparatus **100** configured as above, the light source **140** radiates light towards the document while the full-rate carriage **132** and the half-rate carriage **134** respectively move in the sub-scan direction. In so doing, the photoelectric transducer **138** successively detects reflected light corresponding to the entire surface of the document. Also, in the case where the image reading apparatus **100** previews an image of a document, the photoelectric transducer **138** detects reflected light from a transported document for each sheet at the transported document reading position **186**.

Also, when the carriage moves from under the first white reference plate **150** to a document reading position P_H , the above carriage detector **306** (see FIG. 6) detects that the carriage has passed a reading start position P_S . For example, the detection signal of the carriage detector **306** switches from an off state to an on state at the point when the read line position of the reading unit **130** passes the reading start position P_S and advances to a read area where the transparent member **106** is disposed. Conversely, the detection signal of the carriage detector **306** switches from an on state to an off state at the point when the read line position of the reading unit **130** passes the reading start position P_S and advances to a position under the first white reference plate **150**. As described above, the position of the carriage is recognized from the detection signal of the carriage detector **306**.

(Control Subsystem of Image Forming Apparatus)

Next, a configuration of a control subsystem of an image forming apparatus will be described.

FIG. 5 is a block diagram illustrating an exemplary configuration of the control subsystem of an image forming apparatus according to an exemplary embodiment of the present invention. As illustrated in FIG. 5, the image forming apparatus **10** according to the present exemplary embodiment is equipped with a controller **200**, an image reading controller **202** that controls the action of the above operation display unit **302** and the reading unit **130**, an image forming controller **204** that controls the action of the above image forming unit **12**, a communication unit **206** which is an interface for communicating with external apparatus via a wired or wireless communication link, and a storage unit **208** which is a storage apparatus such as a hard disk. The storage unit **208** stores information such as various data and control programs.

The controller **200** is realized as a computer that controls the apparatus overall and performs various computations. In other words, the controller **200** is equipped with a central

processing unit (CPU) **200A**, read-only memory (ROM) **200B** that stores various programs, random access memory (RAM) **200C** used as a work area during program execution, non-volatile memory **200D** that stores various information, and an input output interface (I/O) **200E**. The CPU **200A**, the ROM **200B**, the RAM **200C**, the non-volatile memory **200D**, and the I/O **200E** are connected to each other via a bus **200F**.

The operation display unit **302**, the image reading controller **202**, the image forming controller **204**, the communication unit **206**, and the storage unit **208** are respectively connected to the I/O **200E** of the controller **200**. The controller **200** respectively controls the operation display unit **302**, the image reading controller **202**, the image forming controller **204**, the communication unit **206**, and the storage unit **208**.

Note that various drives may also be connected to the controller **200**. The various drives may include apparatus that read data from and write data to a computer-readable, portable recording medium, such as a flexible disk, a magneto-optical disc, a CD-ROM, or USB memory. In the case of providing various drives, control programs may be prerecorded onto a portable recording medium, read out with a corresponding drive, and executed.

(Image Reading Controller)

A detailed configuration of the image reading controller **202** will now be described.

FIG. 6 is a block diagram illustrating an exemplary configuration of the image reading controller illustrated in FIG. 5. As illustrated in FIG. 6, the image reading controller **202** is equipped with a controller **210**, an analog processor circuit **220**, an A/D converter circuit **230**, an image processor circuit **240**, a drive circuit **250** that drives the above photoelectric transducer **138**, a drive circuit **260** that drives the carriage **132** (**134**), and a drive circuit **270** that drives the light source **140**.

The controller **210** is equipped with a central processing unit (CPU) **210A**, read-only memory (ROM) **210B** that stores various programs, random access memory (RAM) **210C** used as a work area during program execution, non-volatile memory **210D** that stores various information, and an input output interface (I/O) **210E**. The CPU **210A**, the ROM **210B**, the RAM **210C**, the non-volatile memory **210D**, and the I/O **210E** are connected to each other via a bus **210F**.

In this exemplary embodiment, control programs including a process for switching to a power-saving state and a process for restoring a standby state, to be discussed later, are stored in the ROM **210B** of the controller **210**. These control programs are read out and executed by the CPU **210A** of the controller **210**.

The analog processor circuit **220** is a circuit that conducts various processing on an analog signal expressing image information supplied from the photoelectric transducer **138**. In this exemplary embodiment, the analog processor circuit **220** is configured to include a automatic gain control (AGC) circuit **222** and an automatic offset control (AOC) circuit **224**.

The AGC circuit **222** acquires a gain adjustment value for adjusting the output level of the photoelectric transducer **138** on the basis of the output from the photoelectric transducer **138** when reading an image of a white reference plate, and sets the acquired gain adjustment value in a register or other component of the AGC circuit **222**. Automatic gain control is then applied on the basis of the set gain adjustment value to an analog signal expressing image information when reading an image of a document. In this exemplary embodiment, the set gain adjustment value is stored in the non-volatile memory **210D** of the controller **210**, and used as a set value during the next and subsequent automatic gain control.

Also, the AOC circuit **224** acquires an offset adjustment value for adjusting fluctuations in the dark output of the

photoelectric transducer **138** on the basis of the output from the photoelectric transducer **138** when reading an image of a white reference plate, and sets the acquired offset adjustment value in a register or other component of the AOC circuit **224**. Automatic offset control is then applied on the basis of the set offset adjustment value to an analog signal expressing image information when reading an image of a document. In this exemplary embodiment, the set offset adjustment value is stored in the non-volatile memory **210D** of the controller **210**, and used as a set value during the next and subsequent automatic offset control.

The A/D converter circuit **230** is a circuit that converts a processed analog signal supplied from the analog processor circuit **220** into a digital signal, and supplies digital image information to the image processor circuit **240**.

The image processor circuit **240** is a circuit that conducts various image processing on image information supplied from the A/D converter circuit **230**. In this exemplary embodiment, the image processor circuit **240** is configured to include a shading correction circuit **242**.

The shading correction circuit **242** computes one line's worth of shading correction values used to correct fluctuations in the pixel sensitivity and fluctuations in the intensity distribution of the photoelectric transducer **138**, on the basis of white reference image information acquired by reading an image of a white reference plate. The shading correction circuit **242** stores the computed shading correction values in the non-volatile memory **210D** of the controller **210**. Shading correction is then applied on the basis of the stored shading correction values to digital image information when reading an image of a document.

Herein, "white reference image information" refers to digital image information obtained by conducting automatic gain control and automatic offset control to an analog signal expressing image information when reading an image of a white reference plate, and converting the processed analog signal into a digital signal.

The analog processor circuit **220**, the A/D converter circuit **230**, the image processor circuit **240**, the drive circuit **250**, the drive circuit **260**, and the drive circuit **270** are respectively connected to the I/O **210E** of the controller **210**. The controller **210** respectively controls the analog processor circuit **220**, the A/D converter circuit **230**, the image processor circuit **240**, the drive circuit **250**, the drive circuit **260**, and the drive circuit **270**. In addition, the above power manager **300**, operation display unit **302**, cover state detector **304**, angle detector **305**, and carriage detector **306** are also respectively connected to the I/O **210E** of the controller **210**. The controller **210** respectively exchanges information with the power manager **300**, the operation display unit **302**, the cover state detector **304**, the angle detector **305**, and the carriage detector **306** via the I/O **210E**.

(Power-Saving Function)

A power-saving function of an image forming apparatus according to the exemplary embodiment will now be described.

The reading unit **130** of an image forming apparatus **10** provided with a power-saving function enters a standby state enabling document image reading once boot-up operations finish after the apparatus is powered on. While in the standby state, if the apparatus continues to be unused for a preset amount of time, instructions for switching to the power-saving state are issued, and the apparatus switches to a power-saving state. Whereas the entire image forming apparatus **10** including the reading unit **130** is powered on in the standby state, power is supplied to only part of the image forming apparatus **10** in the power-saving state. For example, power

may be supplied to the operation display unit **302** only. By suspending power supply to predetermined areas of the image forming apparatus **10**, power consumption is reduced.

If the document cover **110** is opened or closed after switching to the power-saving state, the opening or closing of the document cover **110** is detected by the cover state detector **304**, and instructions for restoring the standby state are issued. Also, if a document is placed in the document receptacle **162** of the document transport device **160** after switching to the power-saving state, the document is detected by a document detector (not illustrated), and instructions for restoring the standby state are issued. Also, if a power-saving cancel button (not illustrated) is pressed after switching to the power-saving state, instructions for restoring the standby state are issued. However, these factors for restoring the standby state are given as examples, and instructions for restoring the standby state may also be issued due to other factors. For example, instructions for restoring the standby state may also be issued in the case of receiving an external signal.

If instructions for switching to the power-saving state are issued from the controller **200** of the image forming apparatus **10**, the image reading controller **202** which controls operation of the reading unit **130** executes a predetermined switching process, and switches to the power-saving state. Also, if instructions for restoring the standby state are issued from the controller **200** of the image forming apparatus **10**, the image reading controller **202** executes a predetermined restoring process, and restores the standby state. Hereinafter, the process for switching to the power-saving state and the process for restoring the standby state will be described in detail.

(Switching to the Power-Saving State)

Next, operation for switching to the power-saving state will be described.

FIG. 7 is a flowchart illustrating the sequence of a process for switching to a power-saving state, which is executed according to a first exemplary embodiment of the present invention. The process for switching to the power-saving state is executed by the CPU **210A** of the controller **210**. The process for switching to the power-saving state is initiated after having entered the standby state.

First, in step **100**, it is determined whether or not the controller **200** of the image forming apparatus **10** has issued instructions for switching to the power-saving state. The process proceeds to step **102** in the case where instructions for switching to the power-saving state have been issued. The determination in step **100** is repeated until instructions for switching to the power-saving state are issued. Next, in step **102**, the drive circuit **260** is controlled to move the carriage to the document reading position P_H . Next, in step **104**, a notification indicating that switching preparations are complete is issued to the controller **200** of the image forming apparatus **10**, and the routine ends.

(Restoring the Standby State)

Next, operation for restoring the standby state will be described.

FIG. 8 is a flowchart illustrating the sequence of a process for restoring the standby state, which is executed according to a first exemplary embodiment of the present invention. The process for restoring the standby state is executed by the CPU **210A** of the controller **210**. The process for restoring the standby state is initiated after having entered the power-saving state.

First, in step **200**, it is determined whether or not the controller **200** of the image forming apparatus **10** has issued instructions for restoring the standby state. The process proceeds to step **202** in the case where instructions for restoring

the standby state have been issued. The determination in step **200** is repeated until instructions for restoring the standby state are issued. Next, in step **202**, it is determined whether or not a detection signal has been acquired from the cover state detector **304** which detects the opening and closing of the document cover **110**.

The process proceeds to step **204** in the case where a detection signal from the cover state detector **304** has been acquired. The process proceeds to step **210** in the case where a detection signal from the cover state detector **304** has not been acquired. In other words, the case of not acquiring a detection signal from the cover state detector **304** means that restoration is due to some factor other than a detected opening or closing of the document cover **110**, and thus document size detection may be omitted. Consequently, the process proceeds to step **210** without carrying out the sequence from step **204** to step **208**.

In step **204**, the last gain adjustment value is set in the AGC circuit **222**, and in the following step **206**, the last offset adjustment value is set in the AOC circuit **224**. Next, in step **208**, a document size detection process that detects the size of the document is executed. The document size detection process will be discussed later. Once the document size detection process ends, the process proceeds to the following step **210**.

Next, in step **210**, the drive circuit **260** is controlled to move the carriage under the white reference plate. Next, in step **212**, the drive circuit **270** is controlled to turn on the light source. Next, in step **214**, an image of the white reference plate is read, and a gain adjustment value is acquired and set in the AGC circuit **222**. Next, in step **216**, the drive circuit **270** is controlled to turn off the light source. Next, in step **218**, an image of the white reference plate is read, and an offset adjustment value is acquired and set in the AOC circuit **224**.

Next, in step **220**, the drive circuit **270** is controlled to turn on the light source. Next, in step **222**, white reference image information is acquired. Next, in step **224**, a shading correction value is acquired on the basis of the white reference image information. Next, in step **226**, the carriage is moved to the document reading position P_H . Next, in step **228**, a notification indicating that restoring preparations are complete is issued to the controller **200** of the image forming apparatus **10**, and the routine ends.

(Document Size Detection Process)

Next, the document size detection process will be described. FIG. 9 is a flowchart illustrating the sequence of a document size detection process, which is executed according to a first exemplary embodiment of the present invention. First, in step **300**, it is determined whether or not the document cover is in the nearly closed state, on the basis of detection signals from the cover state detector **304** and the angle detector **305**. The process proceeds to step **302** in the case where the document cover is in the nearly closed state. The determination in step **300** is repeated until the document cover enters the nearly closed state. Next, in step **302**, the drive circuit **270** is controlled to temporarily turn on the light source. Next, in step **304**, an image of a document is read and one line's worth of image information in the scan direction is acquired.

Next, in step **306**, a smoothing process is applied to the one line's worth of image information in the scan direction. Next, in step **308**, the smoothed image information is used to acquire the density change in the scan direction. Next, in step **310**, the document edge is detected on a black background. Since the background becomes black and the document becomes white when the document cover is in the nearly closed state, the position of the document edge becomes the position in the scan direction where the density change from

11

white to black is equal to or greater than a predetermined threshold value. The position of the document edge acquired on a black background is saved to the RAM 210C.

Note that in this exemplary embodiment, the above density change is acquired by the following method. First, an average density value A is computed for a pixel group with a predetermined number of pixels including a first target pixel. Next, an average density value B is computed for a pixel group with a predetermined number of pixels including a second target pixel separated from the first target pixel by a predetermined distance. The absolute value of the difference between the average density value A and the average density value B is then acquired as the density change.

Next, in step 312, it is determined whether or not the document cover is in the closed state, on the basis of a detection signal from the cover state detector 304. The process proceeds to step 314 in the case where the document cover is in the closed state. The determination in step 312 is repeated until the document cover enters the closed state. Next, in step 314, the drive circuit 270 is controlled to temporarily turn on the light source. Next, in step 316, an image of a document is read and one line's worth of image information in the scan direction is acquired.

Next, in step 318, a smoothing process is applied to the one line's worth of image information in the scan direction. Next, in step 320, the smoothed image information is used to acquire the density change in the scan direction. Next, in step 322, the document edge is detected on a white background. Since the background becomes white and the document becomes black when the document cover is in the closed state, the position of the document edge becomes the position in the scan direction where the density change from black to white is equal to or greater than a predetermined threshold value. The position of the document edge acquired on a white background is saved to the RAM 210C.

Next, in step 324, the document size is acquired on the basis of the position of the document edge acquired on a black background and the position of the document edge acquired on a white background, and the routine ends. Note that although this exemplary embodiment describes the example of acquiring both the position of the document edge acquired on a black background and the position of the document edge acquired on a white background, either one of the above may also be acquired. Also, since the position of the document edge acquired on a black background may sometimes differ from the position of the document edge acquired on a white background in the case of acquiring both, an order of priority may be set for both to determine which position to use as a basis for acquiring the document size.

FIG. 10 is a graph illustrating white reference image information. As illustrated in FIG. 10, one line's worth of white reference image information in the scan direction does not express a constant value, due to factors such as fluctuations in the pixel sensitivity of the photoelectric transducer, fluctuations in the light intensity distribution, and noise. For example, from the perspective of fluctuations in the light intensity distribution, the white level at the edges of the scan width in the scan direction is lower than the white level in the center (optical axis center) of the scan width in the scan direction. With a smoothing process, the one line's worth of image information in the scan direction is smoothed, thereby correcting fluctuations in the pixel sensitivity of the photoelectric transducer and density fluctuations due to noise.

In addition, as illustrated in FIGS. 11A and 11B, due to variation in the light intensity distribution of the one line's worth of white reference image information in the scan direction, the density differential between document and back-

12

ground is larger at the optical axis center, and smaller at the edges. Consequently, the threshold value with respect to density change may also change depending on the distance from the optical axis center. In other words, multiple threshold values may be set according to the position in the scan direction (in other words, according to the variation in the light intensity distribution), such as setting a greater threshold value in a region of high white level (the optical axis center) than in a region of low white level (the edge).

For example, threshold values may be varied according to the distance from the optical axis center in a stepwise manner. Alternatively, threshold values may be continuously varied according to the distance from the optical axis center by multiplying a predetermined reference value by a coefficient that depends on the distance from the optical axis center. By varying threshold values according to the distance from the optical axis center (in other words, according to the variation in the light intensity distribution), misdetection at the document edge is reduced, and the document edge detection accuracy improves.

Second Exemplary Embodiment

An image forming apparatus and reading unit according to the second exemplary embodiment have the same configuration as the first exemplary embodiment, with the exception of the sequences of the process for switching to the power-saving state and the process for restoring the standby state. For this reason, description of the apparatus configuration is omitted, and the sequences of the process for switching to the power-saving state and the process for restoring the standby state which are the point of difference will be described.

(Switching to the Power-Saving State)

First, operation for switching to the power-saving state will be described.

FIG. 12 is a flowchart illustrating the sequence of a process for switching to a power-saving state, which is executed according to the second exemplary embodiment of the present invention. The process for switching to the power-saving state is executed by the CPU 210A of the controller 210. The process for switching to the power-saving state is initiated after having entered the standby state.

First, in step 400, it is determined whether or not the controller 200 of the image forming apparatus 10 has issued instructions for switching to the power-saving state. The process proceeds to step 402 in the case where instructions for switching to the power-saving state have been issued. The determination in step 400 is repeated until instructions for switching to the power-saving state are issued. Next, in step 402, the drive circuit 260 is controlled to move the carriage under the white reference plate.

Next, in step 404, the drive circuit 270 is controlled to turn on the light source. Next, in step 406, an image of the white reference plate is read, and a gain adjustment value is acquired and set in the non-volatile memory 210D. Next, in step 408, the drive circuit 270 is controlled to turn off the light source. Next, in step 410, an image of the white reference plate is read, and an offset adjustment value is acquired and set in the non-volatile memory 210D. Next, in step 412, a notification indicating that switching preparations are complete is issued to the controller 200 of the image forming apparatus 10, and the routine ends.

(Restoring the Standby State)

Next, operation for restoring the standby state will be described.

FIG. 13 is a flowchart illustrating the sequence of a process for restoring the standby state, which is executed according to

13

the second exemplary embodiment of the present invention. The process for restoring the standby state is executed by the CPU 210A of the controller 210. The process for restoring the standby state is initiated after having entered the power-saving state.

First, in step 500, it is determined whether or not the controller 200 of the image forming apparatus 10 has issued instructions for restoring the standby state. The process proceeds to step 502 in the case where instructions for restoring the standby state have been issued. The determination in step 500 is repeated until instructions for restoring the standby state are issued. Next, in step 502, it is determined whether or not a detection signal has been acquired from the cover state detector 304 which detects the opening and closing of the document cover.

The process proceeds to step 504 in the case where a detection signal from the cover state detector 304 is acquired. The process proceeds to step S14 in the case where a detection signal from the cover state detector 304 has not been acquired. Since the carriage is moved under the white reference plate when switching to the power-saving state, in step S504 the drive circuit 260 is controlled to move the carriage to the document reading position. Next, in step 506, the previously stored gain adjustment value is set in the AGC circuit 222, and in the following step 508, the previously stored offset adjustment value is set in the AOC circuit 224.

Next, in step S10, a document size detection process that detects the size of the document is executed. Since the document size detection process herein has the same sequence as in the first exemplary embodiment, description thereof will be omitted. Once the document size detection process ends, the process proceeds to the following step S12. Since the sequence from step S12 to step S30 is also the same as the sequence from step 210 to step 228 in FIG. 8, description thereof will be omitted. In the second exemplary embodiment, in step S30, a notification indicating that restoring preparations are complete is issued to the controller 200 of the image forming apparatus 10, and the routine ends.

Third Exemplary Embodiment

An image forming apparatus and reading unit according to the third exemplary embodiment have the same configuration as the first exemplary embodiment, with the exception of the sequences of the process for switching to the power-saving state and the process for restoring the standby state. For this reason, description of the apparatus configuration is omitted, and the sequences of the process for switching to the power-saving state and the process for restoring the standby state which are the point of difference will be described.

(Switching to the Power-Saving State)

First, operation for switching to the power-saving state will be described.

FIG. 14 is a flowchart illustrating the sequence of a process for switching to a power-saving state, which is executed according to the third exemplary embodiment of the present invention. The process for switching to the power-saving state is executed by the CPU 210A of the controller 210. The process for switching to the power-saving state is initiated after having entered the standby state.

First, in step 600, it is determined whether or not the controller 200 of the image forming apparatus 10 has issued instructions for switching to the power-saving state. The process proceeds to step 602 in the case where instructions for switching to the power-saving state have been issued. The determination in step 600 is repeated until instructions for switching to the power-saving state are issued. Next, in step

14

602, it is determined whether or not the document cover is in the closed state, on the basis of a detection signal from the cover state detector 304.

In the case where the document cover is in a closed state, the process proceeds to step 604, and the drive circuit 260 is controlled to move the carriage under the white reference plate. In the case of switching to the power-saving state with the document cover in the closed state, subsequently the document cover will be opened, a document will be placed, and the document cover will be closed. Since the image forming apparatus switches to the standby state upon detecting that the document cover has been opened, there is still time to move the carriage to the document reading position P_H and detect the document size during restoration, even if the carriage is moved under the white reference plate. Next, in step 606, a notification indicating that switching preparations are complete is issued to the controller 200 of the image forming apparatus 10, and the routine ends.

On the other hand, in the case where the document cover is not in the closed state, or in other words the case where the document cover is in the open state, the process proceeds to step 608, and the drive circuit 260 is controlled to move the carriage to the document reading position P_H . In the case of switching to the power-saving state with the document cover in the open state, subsequently a document will be placed, and the document cover will be closed. Since the image forming apparatus switches to the standby state upon detecting that the document cover has been closed, moving the carriage under the white reference plate entails the risk that there may not be enough time ensured to move the carriage to the document reading position P_H and detect the document size during restoration. Consequently, the carriage is moved to the document reading position P_H to enable document size detection to be reliably conducted. Next, in step 606, a notification indicating that switching preparations are complete is issued to the controller 200 of the image forming apparatus 10, and the routine ends.

(Restoring the Standby State)

Next, operation for restoring the standby state will be described.

FIG. 15 is a flowchart illustrating the sequence of a process for restoring the standby state, which is executed according to the third exemplary embodiment of the present invention. The process for restoring the standby state is executed by the CPU 210A of the controller 210. The process for restoring the standby state is initiated after having entered the power-saving state.

First, in step 700, it is determined whether or not the controller 200 of the image forming apparatus 10 has issued instructions for restoring the standby state. The process proceeds to step 702 in the case where instructions for restoring the standby state have been issued. The determination in step 700 is repeated until instructions for restoring the standby state are issued. Next, in step 702, it is determined whether or not a detection signal has been acquired from the cover state detector 304 which detects the opening and closing of the document cover.

The process proceeds to step 704 in the case where a detection signal from the cover state detector 304 is acquired. The process proceeds to step 714 in the case where a detection signal from the cover state detector 304 has not been acquired. Next, in step 704, it is determined whether or not the carriage is under the white reference plate. In the case where the carriage is under the white reference plate, the process proceeds to step 706, and the drive circuit 260 is controlled to move the carriage to the document reading position. In contrast, the process proceeds to step 708 in the case where the

15

carriage is not under the white reference plate, or in other words, is at the document reading position.

Next, in step 708, the last gain adjustment value is set in the AGC circuit 222, and in the following step 710, the last offset adjustment value is set in the AOC circuit 224. Next, in step 712, a document size detection process that detects the size of the document is executed. Since the document size detection process herein has the same sequence as in the first exemplary embodiment, description thereof will be omitted. Once the document size detection process ends, the process proceeds to the following step 714. Since the sequence from step 714 to step 732 is also the same as the sequence from step 210 to step 228 in FIG. 8, description thereof will be omitted. In the third exemplary embodiment, in step 732, a notification indicating that restoring preparations are complete is issued to the controller 300 of the image forming apparatus 10, and the routine ends.

Note that the configurations of an image reading apparatus and method, an image forming apparatus, and a computer-readable medium described in the foregoing exemplary embodiments are examples, and that obviously these configurations may also be modified within a scope that does not depart from the principal matter of the present invention.

For example, although the foregoing exemplary embodiments describe an example of a configuration in which an offset adjustment value is set in an AOC circuit, it may also be configured such that an analog processor circuit uses the mask pixels of a photoelectric transducer to automatically adjust the black level, or such that an analog processor circuit is made to automatically adjust the black level without using the last offset adjustment value.

The foregoing description of the exemplary embodiments of the present invention has been provided for the purposes of illustration and description. It is not intended to be exhaustive or to limit the invention to the precise forms disclosed. Obviously, many modifications and variations will be apparent to practitioners skilled in the art. The embodiments were chosen and described in order to best explain the principles of the invention and its practical applications, thereby enabling others skilled in the art to understand the invention for various embodiments and with the various modifications as are suited to the particular use contemplated. It is intended that the scope of the invention be defined by the following claims and their equivalents.

What is claimed is:

1. An image reading apparatus comprising:

a document cover;

a cover state detector configured to detect whether the document cover is open or closed;

an image reading unit configured to read an image of a target object by conducting an optical scan that moves a scanning body with a mounted light source, detecting reflected light from the target object with a photoelectric transducer, and outputting a signal expressing the detected pixel densities;

a white reference plate configured as a reference for correcting an image;

a power manager configured to switch between a power-saving state and a standby state in which more power is supplied to the image reading apparatus than in the power-saving state; and

a controller configured to control the image reading apparatus to restore the standby state,

wherein the controller is configured to, in response to the standby state being restored in response to detecting opening or closing of the document cover, control the image reading apparatus to read an image of a document

16

to detect a document size, and after the detection of document size, read an image of the white reference plate to acquire correction values,

wherein the controller is configured to control the image reading apparatus such that, in response to switching to the power-saving state while the document cover is in an open state, the scanning body is moved to a document reading position before switching to the power-saving state, and

wherein the controller is also configured to control the image reading apparatus such that, in response to switching to the power-saving state while the document cover is in a closed state, the scanning body is moved to and stopped at a position directly under the white reference plate before switching to the power-saving state.

2. The image reading apparatus according to claim 1,

wherein the controller is configured to, in response to the standby state being restored in response to a factor other than detecting the opening or closing of the document cover, control the image reading apparatus to read an image of the white reference plate to acquire correction values.

3. The image reading apparatus according to claim 1, wherein the controller is configured to, in response to a trigger for the standby state being restored, the trigger being detecting opening or closing of the document cover by the cover state detector, set a preset gain adjustment value and control the image reading apparatus to read the image of the document to detect the document size using the preset gain adjustment value.

4. The image reading apparatus according to claim 1, wherein the controller is configured to detect the document size after applying a smoothing process to the read image of the document.

5. The image reading apparatus according to claim 1, wherein the controller is configured to read an image of the document in a first direction intersecting a movement direction of the scanning body, compute a density change in the first direction, detect a position where a magnitude of density change becomes equal to or greater than a threshold value as a document edge position, and detect the document size using the document edge position.

6. The image reading apparatus according to claim 5, wherein a plurality of threshold values are set using the density change in response to reading an image of the white reference plate in the first direction, such that a threshold value for a region of high white level is greater than a threshold value for a region of low white level.

7. The image reading apparatus according to claim 1, wherein the controller is configured to control the image reading apparatus so as to move the scanning body under the white reference plate and switch to the power-saving state after the moving.

8. An image forming apparatus comprising:

the imaging reading apparatus according to claim 1.

9. The image reading apparatus according to claim 1, wherein the controller is configured to, while the image reading apparatus is in the standby state, control the image reading apparatus to, in response to detecting opening or closing of the document cover, read an image of a document to detect document size, and after the detection of document size, read an image of the white reference plate to acquire correction values.

10. The image reading apparatus according to claim 1, wherein the controller is configured to control the image reading apparatus such that, in response to switching to the power-saving state while the document cover is in the closed

17

state, the scanning body is moved to and stopped at the position under the white reference plate before switching to the power-saving state, and the scanning body remains stopped at the position while switching to the power-saving state.

11. The image reading apparatus according to claim 1, wherein the controller is configured to, in response to the standby state being restored in response to detecting opening of the document cover, control the image reading apparatus to read an image of a document to detect a document size, and after the detection of document size, read an image of the white reference plate to acquire correction values.

12. A method for controlling an image reading apparatus, the method comprising:

receiving restoration instructions for restoring a standby state from a power-saving state,
wherein more power is supplied to the image reading apparatus in the standby state than in the power-saving state;

in response to receiving the restoration instructions in response to detecting opening or closing of a document cover, detecting a document size by reading an image of a document;

after the detecting the document size, acquiring correction values by reading an image of a white reference plate;

in response to switching to the power-saving state while the document cover is in an open state, moving a scanning body to a document reading position before switching to the power-saving state; and

18

in response to switching to the power-saving state while the document cover is in a closed state, moving the scanning body to and stopping the scanning body at a position directly under the white reference plate before switching to the power-saving state.

13. A non-transitory computer readable medium storing a program causing a computer to execute a process for controlling an image reading apparatus, the process comprising:

receiving restoration instructions for restoring a standby state from a power-saving state,
wherein more power is supplied to the image reading apparatus in the standby state than in the power-saving state;

in response to receiving the restoration instructions in response to detecting opening or closing of a document cover, detecting a document size by reading an image of a document;

after the detecting the document size, acquiring correction values by reading an image of a white reference plate;

in response to switching to the power-saving state while the document cover is in an open state, moving a scanning body to a document reading position before switching to the power-saving state; and

in response to switching to the power-saving state while the document cover is in a closed state, moving the scanning body to and stopping the scanning body at a position directly under the white reference plate before switching to the power-saving state.

* * * * *